

# Climate Resilience Vulnerability Assessment



Potts Point and Lookout Point Road Landings



Lowell's Cove Road, Orr's Island

Town of  
Harpswell  
October 2020

**Mission:** To assess vulnerabilities and resilience on  
the Town's infrastructure



# Harpswell's Climate Resilience Task Force Strategic Assessment

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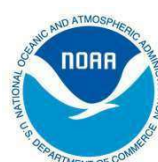
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## Acknowledgements

Upon receipt of a *ShoreUp* grant from The Island Institute, the Town of Harpswell Climate Resilience Taskforce was formed to assess the Town's vulnerability to flooding and climate change. The Maine Flood Resilience Checklist developed by the Maine Coastal Program at the Department of Agriculture, Conservation and Forestry, under a *CZM NA17NOS4190116* award from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce was used as the backbone of the assessment process.

The assessment was completed in partnership with the Midcoast Economic Development District, with input from Town staff, Town committees, local businesses, the local library and local nonprofit conservation organizations.

Photos courtesy of J. Lloyd, M. Nahf, and P. Plummer



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Reports and maps at:

[www.harpswell.me.gov](http://www.harpswell.me.gov) *Environmental*



**Harpswell Conservation  
Commission**



## Climate Resilience Vulnerability Assessment

### INTRODUCTION:

The Climate Resilience Task Force was formed to assess Harpswell's resiliency to coastal flooding caused by sea level rise and storm surge from high windstorms. A number of years ago, the Conservation Commission began looking at how rising tides could impact Harpswell in the future. Members mapped areas that could become inundated from extreme weather events and identified roads that were at risk. Mapping indicated that seven (7) public and private roads were at risk with just one (1) foot of rise and many already overtop on king tides when accompanied by storm surge. To get a sense of cost, as a pilot project, the Town took a detailed look at how Basin Point Road, a Town road, and its residents might be impacted and how the impacts could be addressed. After learning what would be involved to remediate just one road, the Commission decided to step back and take a holistic look at how rising tides could impact various areas of community infrastructure.

In June 2019, the Town received an Island Institute *Shore-Up* Grant. The Selectmen created the Climate Resilience Task Force to do a systematic assessment of the potential impacts from rising tides and storm surge on all aspects of community infrastructure. The Task Force included town staff, town committee members and community representatives. Members of the Task Force are listed in Appendix A. In addition, interested residents were invited to attend the workshops to add a broader perspective to the discussion.

Working with the Town's existing emergency management, community and fiscal planning policies, the Task Force assessed where Harpswell could integrate changing climate and increased storm event remediation actions into existing policy and determine where new emphasis will need to be placed.

Discussion included ways to share information with the community as outcomes from the study become available and new materials come along. The community representatives provided valuable insight in how we might engage with residents going forward.

NOAA's North Carolina Institute for Climate Studies (NCICS), 2017 prediction for a rise in sea level in Portland Harbor is one to four feet by 2100. For our planning purposes the Task Force concentrated on impacts to infrastructure from one to three feet of rise in the next 30 years (2050) Note: many locations subject to storm surge are already experiencing the equivalent of one foot tide rise during a monthly king tide when it is accompanied by high winds.

The findings of the Task Force will serve as a guideline for public officials and residents of Harpswell to consider when planning improvements to existing infrastructure.

## PROCESS:

Using the "Maine Flood Resilience Checklist" prepared by the Maine Department of Agriculture, Conservation and Forestry, the Task Force reviewed Harpswell's constructed, natural, and social environments to understand where the Town has exposure to flooding and storm surge. Initially, the group reviewed existing plans and policies to see where flooding hazards were addressed. The group then identified specific intervention points and developed actions to address the areas of vulnerability. The Checklist process has potential to help Harpswell integrate sea level rise considerations into its Emergency Operations Plan (EOP), Comprehensive Plan, reconsider its local floodplain ordinance, and incorporate resilience activities into the Town's capital road improvement plans.

Members of the Task Force assessed coastal flood and storm surge vulnerability and its possible impacts on Harpswell's:

- Critical Infrastructure and Facilities (energy, potable water, wastewater systems)
- Natural Environment
- Social and Economic Community

The following sections list the vulnerable areas, actions to be performed, implementation responsibilities and a time frame.

## ASSESSED GROUPS

### Critical Infrastructure

The Maine Flood Resilience Checklist includes many topics that are not relevant to Harpswell. Our analysis focused on the sections that address the areas potentially impacted by a changing climate in our town.

Harpswell's critical infrastructure includes Town buildings<sup>i</sup>, landings, boat launches, piers, wharves, recreation fields, non-developed land, and roads, which make up the largest sector.

The Town's headquarters for emergency fire and medical services, cemeteries, historic buildings, and conserved land were assessed, but are not significantly impacted.

The recommendations for this section are to identify sites and facilities that are vulnerable and lay out strategies to reduce their vulnerabilities.

- **Town Lands:** The current situation of Town-owned landings and boat launches should be regularly monitored and documented with special attention paid to king and other extremely high tides as well as storm surges. The committee should keep photographic documentation to help monitor changes over time. If there are potentially critical situations, do a simple assessment of how 1-2-3 feet of sea level rise (SLR) would affect these facilities. If rising tide levels compromise the usability of a facility, then start to plan for what can/should be done to mitigate the problem. A list of Town Landings is included in Appendix B.

- Choose one landing that is most likely to be impacted and do a preliminary assessment of what might need to be done to accommodate sea level rise, what the impediments are and approximate cost.
  - Implementation by Town Lands and Harbor and Waterfront Committees and Harbormaster/Marine Resources Administrator
  - Timeframe: 1-3 years.
  
- **Intertidal Area and Shellfish Harvesting:** Harpswell has the largest combined total of intertidal acreage in Casco Bay. The mudflats provide a workplace for commercial shellfish harvesters as the Town exercises control of the intertidal through the Municipal Shellfish Conservation Program, in conduction with the Maine Department of Marine Resources. It is important to consider how climate change will affect the shellfish species and intertidal acreage in the near future.
  - Begin to assess how temperature, ocean acidification will affect shellfish species.
  - Assess what intertidal areas will lose and gain acreage.
  - Implementation by Marine Resources and Harbormaster/Marine Resources Administrator
  - Timeframe: 1-3 years
  
- **Harpswell's Harbor & Waterfront:** Harpswell's harbors and waterfront resources are a formidable town asset. The number of participants and the intensity of demands that are placed on these fixed harbor resources is growing. Climate resilience should be considered as the committee incorporates plans outlined in the Coastal Waters Management Plan.
  - Gather input from economic sectors, such as commercial fishing wharves, marinas, and shorefront businesses to find out what they foresee as strategies to mitigate the problems arising from sea level rise and storm surge.vulnerabilities
  - Implementation by Harbor and Waterfront Committee, Harbormaster/Marine Resources Administrator, and the Fisheries
  - Timeframe: 1-3 years.
  
- **Facilities:** Included sectors are energy, communications, private drinking water and septic systems. The energy and communications sectors are included within the Town's Emergency Operations Plan (EOP).
  - Research ways to assess vulnerability of public and private wells to saltwater intrusion.
  - Rising sea and groundwater levels will impact the lowest lying areas of Harpswell. Septic system leech fields in these areas may be impacted. Analyze low lying developable areas to identify septic systems that will be vulnerable to rising sea levels of 1-3 feet. .
    - Implementation by Planner and Conservation Commission
    - Timeframe: 1- 4 yrs.

- **Roads:** Harpswell has 153<sup>ii</sup> miles of 911 roads. The maintenance of approximately 28.5 miles is the responsibility of the State and 27.8 miles are Town owned. Two thirds of the



roads, 96.7 miles, are private. A list of Town public and private roads that will be affected by 1, 2, 3.3 and 6 feet of sea level rise is included in Appendix C at the end of this report.

- Select an additional one or two Town roads that are most likely to be the first roads impacted and do a preliminary assessment of what might need to be done to accommodate sea level rise and what the impediments are – i.e. topography, wetlands, buildings, etc. This would be a very preliminary assessment to begin to understand if the road(s) can be elevated and what might be involved. Depending on the assessment, the next steps would be outlined including looking at alternatives.
- Continue to meet with Maine Dept. of Transportation (DOT) to discuss mitigation plans related to flooding and storm surge on State roads and bridges.
- Factors to consider in prioritizing Town roads for mitigation/adaption when making major repairs:
  - Is the road impacted by 1 - 3 feet of sea level rise?
  - Is the road impacted by 4 - 6 feet of sea level rise?
  - Will the road require repair within 5 years?
  - Is there an alternative access point to the road?
  - Determine the feasibility of addressing a 2-3 feet of sea level rise when replacing culverts.
- Include above factors as part of the Town Roads Capital Improvement Program matrix.
- Disseminate information to private road owners regarding mitigation, maintenance and funding opportunities related to sea level rise.
  - Implementation by Planner, Road Commissioner and Conservation Commission
  - Timeframe: 1-5 years

## NATURAL ENVIRONMENT

The natural environment presents an opportunity to evaluate potential conservation possibilities that would provide mitigation or adaptation to sea level rise and climate changes in the areas of coastal and natural resources.

In 2011, three Bowdoin students' semester study produced a report on Harpswell's Intertidal, Wetlands, Watersheds, Eelgrass and Erosion<sup>iii</sup>. The students studied the resources stated in the title to help Harpswell to begin thinking strategically about conservation of its coastal and natural resources.

The Casco Bay Estuary Partnership's 2013 report Sea level Rise and Casco Bay's Wetlands: Harpswell Edition mapped its wetlands and evaluated potential areas of marsh migration and possible impacts to existing developed areas due to tidal inundation from sea level rise<sup>iv</sup>

- Incorporate impacts identified in the 2011 and 2013 reports with reported information from new testing being recommended under Community Planning.
  - Implementation by Planner and Conservation Commission

- Timeframe: 1- 4 years

## **SOCIAL AND ECONOMIC COMMUNITY**

Harpwell Aging at Home's community assessment provided current data of our seniors' social and economic status.<sup>v</sup> To address the social and economic needs of the working community similar information is needed to preserve Harpswell's critically important economic working waterfront and tourism industries.

When Harpswell's Emergency Operation Plan (EOP)<sup>vi</sup> was reviewed for social and economic vulnerability, it was noted that many checklist items are being addressed in the EOP.

Harpwell's quick and robust emergency response for COVID19 highlighted the nimbleness of the 2016 Plan. New Vulnerabilities related to sea level rise and storm surge that were not included will need to be added.

- Using The Nature Conservancy, (TNC) coastal resilience assessing tool, determine the social and economic needs of the working community.
- Integrate vulnerabilities to rising tides and storm surge mitigation into the Emergency Operations Plan.
  - Study ways to determine locations of those who use medical devices that need electricity

## **COMMUNITY PLANNING**

Community Planning focuses on understanding the current situation regarding the flooding of Harpswell structures and the impacts of sea level rise on future land development in projected flood hazard areas.

Due to Harpswell's 216 miles of irregular shore composed of steep rocky shoreline, areas of relatively low sloping flat land and many small coves, more granular mapping and analysis is needed before the Town can evaluate and manage current regulations in respect to the impacts of sea level rise and storm surge.

A disconnect between the Federal Emergency Management Agency (FEMA) maps and Harpswell's actual activity was apparent when the new 2017 FEMA maps were published for the Town. History didn't seem to back up the new maps and Ransom Engineering was hired to model Harpswell's shoreline. Their findings are still under review by FEMA.

- To give the Town a really good baseline to look at the implications of sea level rise, it should develop a "climate change risk assessment" map that takes the updated flood hazard map developed by Ransom Engineering for the Town and adds 2-3 feet of sea level rise to it. This would need to be discussed with Ransom since this might not be a simple "addition" for the wave action modeling.
  - Implemented by: Planner & Conservation Commission
  - Timeframe: 1-2 years

- Using the map developed by Ransom Engineering, do a land use analysis to identify where 1-3 feet of sea level rise could impact developed and undeveloped land and assess if changes in regulations are needed.
  - Implementation by Planner, Planning Board & Conservation Commission
  - Timeframe: 2-3 years
- Using data determined in the above study, revisit the Casco Bay Estuary Partnership's 2013 marsh migration analysis based on the risk assessment map and reports described in the Natural Resources Section to determine if expanded or new RP Districts should be considered.
- Review the Maine Climate Council's Action Plan when released in December 2020 to see what strategies could be incorporated to strengthen our resiliency.
  - Implementation by Planner, Implementation group & Conservation Commission
  - Timeframe: 3-4 years

## COMMUNICATION AND OUTREACH

- Keep the community abreast of climate resiliency news and changes.
  - Use local libraries in addition to online resources as depositories of documentation and programming relating to Climate Resilience.
  - Present information in a manner that is local
  - Consider interpretive signage to show areas where road frequently overtops
    - Implementation by Communication and Outreach Group and Implementation group
    - Timeframe: 1- 5 years.

## SUMMARY:

The Task Force evaluated exposure to Harpswell's critical infrastructure and natural resources and identified steps toward reducing vulnerabilities to sea level rise and storm surge. Once the group identified the affected areas, it assembled a strategic work plan that laid out specific action steps to quantify the vulnerabilities, a time frame and an implementation group. It became apparent during the assessment that more targeted data will be needed before a plan for mitigation or adaptation can be developed. Action items are included with each section that will provide goals toward attaining the needed detail to present a mitigation or adaptation strategy.

## NEXT STEPS AND RECOMMENDATIONS:

The completed assessment highlights Harpswell's vulnerabilities and contains action items toward getting a better understanding of the specifics. It was determined that more targeted assessments were needed before the Town can plan a strategy for mitigation or adaption.

After completion of the Climate Resilience Checklist many members of the Task Force felt they were just getting started and would like to continue to work on implementing actions toward resilience. The members felt it equally important to keep the conversation ongoing with the

community by keeping them abreast of outcomes and new information on an ongoing basis. They discussed how an active Town Climate Resilience Action plan could become a positive for the Community as it looked for grant funding or borrowing.

**Next Steps:** To keep climate resilience in the forefront, the Task Force recognized the need to continue carrying out the action items and to keep a focus on climate resilience in the Town.

As the group reviewed the findings of the report and began to think of next steps they noted the action items were to take place over the next five (5) years and that most of the implementation responsibility included a Town committee member in conjunction with a staff member and a community member. Below is an outline of how they see the work progressing going forward.

- Complete the Report's Action Items through the appropriate working group to determine the degree of exposure from one to three feet of sea level rise looking out 30 years (2050)
- Continue to compile data for the Town to make sound budgetary plans for adaptation and/or mitigation of vulnerable areas.
- Keep the community updated and informed as new climate hazards occur because of climate change
- Work independently through their respective working group and meet as a group 4 times a year.

**Recommendations:** The Climate Resilience Task Force recommends that a Climate Resilience Implementation Task Force be formed. The Climate Resilience Implementation Task Force (CRITF) would function by dividing into working groups to carry out the action items recommended in this final report and bring back their results to the full Task Force. The CRITF would agree on the working groups needed and what skills and knowledge are needed in each group. Members of the Task Force would include relevant staff members and be appointed by the Selectmen.

The CRITF would meet four times a year to review and share the findings of each working group. Progress reports would be prepared by each working group to share with the full Task Force. The Conservation Commission could manage the administrative segment of the CRITF by providing support for record keeping, scheduling, minutes, etc. and following implementation progress. It should be noted that the CRITF is not a part of the Conservation Commission but a separate entity.

Before suggesting it administer the ongoing items from the CRITF, the Commission reviewed its Mission Statement and felt it would be consistent with its mission "to protect the Town's natural resources and open areas and that of working with existing Town committees" and its goal to promote local resilience to marshes and road infrastructure as they relate to changing weather.

The Conservation Commission is committed as it has been actively studying sea level rise and storm surge since 2012, has secured grant funds to study climate resilience<sup>i</sup> and will continue to have an active interest in climate resiliency. And as a statutory body, the Conservation Commission has permanency to take on a coordinator/administrator role to shepherd the ongoing items.

The Conservation Commission supports the Taskforce's recommendation that a Climate Resilience Implementation Task Force be established and agrees to its supporting role on the new Task Force.

#### References:

<sup>i</sup> Old Town Meeting Hall, Town Office, Recycling Center, Emergency

<sup>ii</sup> Maine Geological Survey 2015 MGIS 911 data

<sup>iii</sup> [Harpwell Intertidal, wetlands, watersheds, eelgrass, and erosion](#), Richard Joyce, Claire Ellwangen and Tim Farley December 13, 2011 ES 204

<sup>iv</sup> [Sea Level Rise and Casco Bay's Wetlands: A Look at Potential Impacts](#)--Harpwell edition, Casco Bay Estuary Partnership, pg. 3

<sup>v</sup> [Harpwell At Home Community Assessment Report](#), January 2016 <https://harpwell.maine.gov> Side Bar Documents

<sup>vi</sup> [Town of Harpswell Emergency Operations Plan](#), 7/7/2016, <https://harpwell.maine.gov> Side bar Documents

<sup>vi</sup> "Planning for Basin Point Road and its Wetlands", 2017

## Appendix A

Climate Resilience Task Force Members	
Members	Affiliations
Ken Oehmig	Town Lands Committee
Billy Saxton	Harbor and Waterfront Committee/Marinas
Jack Dostie	Harbor and Waterfront Committee/ marine Captain/Energy Auditor
Mary Ann Nahf	Harpswell Conservation Commission/Task Force administrator
Deirdre Strachan	Harpswell Conservation Commission/Task Force administrator, Holbrook Community Foundation
Joanne Rogers	Planning Board/Orr's Island Library, Wharf Owner/Bailey & Orr's Islands
Jay Mc Creight	Harpswell Aging at Home, Maine Representative, State Marine Resource Committee Great Island, Gun Point Area
Bruce Davis	Local Realtor/Bailey & Orr's Islands
Bill Mangum	Holbrook Community Foundation/Cundy's Harbor
Monique Coombs	Maine Coast Fishermen Association /Working Waterfront/ Bailey & Orr's Islands
Reed Coles	Harpswell Heritage Land Trust/South Harpswell
Dick Mosley	Harpswell Business Association/South Harpswell
Ned Simmons	Board of Appeals /Business Owner/Great Island
<b>Participating Staff:</b>	
Art Howe	Fire Administrator/Emergency Management Agent
Paul Plummer	Harbormaster/Marine Resource Administrator
Mark Eyerman	Town Planner

**Appendix B**  
**Town Owned Landings and Boat Launches**

Bethel Point  
Garrison Cove  
Hildreth Road  
Holbrook Street  
Lookout Point Road  
Mackerel Cove  
Pott's Point

**Landings with little or no ability to launch a boat**

Graveyard Point  
Merritt House  
York's Landing (Steamboat Road)  
Steamboat Wharf Lane  
Stover's Landing  
Tide Mill (Ash Point)  
Wharf Road  
Wood Point (currently leased out)

## Appendix C

### Harpswell Public Roads Affected by Rising Tides & Storm Surge

Public Roads	1 foot	2 feet	3.3 feet	6 feet
<b><u>Harpswell Neck:</u></b>				
Basin Point Road – Head of Basin Cove	X	X	X	X
Lookout Point Road. (Lower End)	X	X	X	X
Windsor Lane (Stover's Point Area)	X	X	X	X
Route 123 – Causeway to Potts Point			X	X
Harpswell Neck Rd. Rte.123 – Skofield Cove, Near town Line			X	X
<b><u>Great Island:</u></b>	-	-	-	-
Long Point Road – Near intersection with Little Crow Point	X	X	X	X
Long Point Road – Near intersection with Dirigo Lane			X	X
<b><u>East Harpswell/Cundy's Harbor</u></b>	-	-	-	-
Dingley Island Road – Bridge		X	X	X
Bethel Point Road – Bridge		X	X	X
Oakhurst Island Road – Either side of bridge			X	X
Bethel Point Road – Culvert near Little Ponds Road				X
<b><u>Orr's and Bailey Island:</u></b>				
Lowell's Cove Rd. - Orr's Island	X	X	X	X
Abner Point Rd. at Lube Dr.- Bailey Island		X	X	X
Garrison Cove Road (near Cribstone Bridge)			X	X
Harpswell Islands Rd (Rte.24) - Bridge connecting Great & Orr's Islands, at Eagle Bluff -				X
Harpswell Islands Road (Rte.24 ) –Each end of Cribstone Bridge				X



## Appendix C

### Harpswell Private Roads Affected by Rising Tides & Storm Surge

Private Roads	1 foot	2 feet	3.3 feet	6 feet
<b><u>Harpswell Neck:</u></b>				
High Head Road – Bridge		X	X	X
Stucarro Drive (Lower end)			X	X
Intervale Road				X
<b><u>Great Island:</u></b>	-	-	-	
Little Crow Point (past intersection with Tuttle Road)	X	X	X	X
Tuttle Road/Long Point Road/Little Crow Point		X	X	-
Gun Point Road (near intersection with Long Point Road)			X	X
<b><u>East Harpswell/Cundy's Harbor</u></b>	-	-	-	
Wallace Shore Road (both before and after bridge)	X	X	X	X
Shore Road		X	X	X
Hopkins Island Road			X	X
Cundy's Point Road				X
Sailor's Way				X
<b><u>Orr's and Bailey Island:</u></b>				
Johnson Point Road - Orr's Island				X
-				
-				

## Appendix D

### **Maine Flood Resilience Checklist: – Resources and Recommendations August 2017**

#### **Maine Coastal Communities mapper**

<https://coastalresilience.org/project/maine/>

#### **State Resources**

- Maine Coastal Program
  - Grant opportunities <http://www.maine.gov/dacf/mcp/grants/index.html>
- Maine Floodplain Management Program
  - Maine Flood Hazard Map\_ <http://maine.maps.arcgis.com/apps/webappviewer/index.html?id=3c09351397764bd2aa9ba385d2e9efe7>
- Maine Geological Survey
  - Highest Annual Tide Line 2015 <http://www.maine.gov/dacf/mgs/hazards/hat/index.shtml>
  - Sea Level Rise/Storm Surge map viewer and data [http://www.maine.gov/dacf/mgs/hazards/slr\\_ss/index.shtml](http://www.maine.gov/dacf/mgs/hazards/slr_ss/index.shtml)
  - Sea Lake and Overland Surges from Hurricanes (SLOSH) map viewer and data <http://www.maine.gov/dacf/mgs/hazards/slosh/index.shtml>
  - Coastal Sand Dune Geology Maps <http://www.maine.gov/dacf/mgs/pubs/online/dunes/dunes.htm>
  - Coastal Bluff Maps <http://www.maine.gov/dacf/mgs/pubs/online/bluffs/bluffs.htm>
- Maine Municipal Assistance Program
  - Information and resources for planning for climate variability <http://www.maine.gov/dacf/municipalplanning/technical/climate.shtml>
- Maine Natural Areas Program
  - Potential Tidal Marsh Migration map viewer and data [http://www.maine.gov/dacf/mnap/assistance/marsh\\_migration.htm](http://www.maine.gov/dacf/mnap/assistance/marsh_migration.htm)
  - Coastal Undeveloped Blocks After 1 m of Sea Level Rise map viewer and data [http://www.maine.gov/dacf/mnap/assistance/coastal\\_blocks\\_1m\\_slr.htm](http://www.maine.gov/dacf/mnap/assistance/coastal_blocks_1m_slr.htm)
  - Conserved Lands <http://www.maine.gov/dacf/mnap/assistance/conslands.htm>
- Maine Department of Environmental Protection
  - Climate Adaptation Toolkit <http://www.maine.gov/dep/sustainability/climate/adaptation-toolkit/index.html>
- Maine Emergency Management Agency
  - Hazard mitigation <http://www.maine.gov/mema/mitigation/index.shtml>

#### **I. Risk and Vulnerability**

In addition to data sources and mapping tools listed in the “Resources to Get Started” section above, there are a number of resources, data, and tools available that can help your community understand local flood risk, assess impacts, and take action to decrease vulnerability.

## Resources

### Assessing Risk and Vulnerability

- NOAA's *Coastal Flood Exposure Mapper* is an online visualization tool for assessing coastal hazard risks and vulnerabilities that enables users to explore and create a collection of user-defined, savable and downloadable maps showing people, infrastructure, and natural resources exposed to coastal flood hazards. <https://coast.noaa.gov/digitalcoast/tools/flood-exposure.html>
- HAZUS-MH is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. It uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disaster. <https://www.fema.gov/hazus>
- The NOAA Coastal Services Center developed an on-line training module *The Roadmap for Adapting to Coastal Risk*, a participatory approach for assessing vulnerability to hazards and for incorporating relevant data and information about hazards and climate into ongoing local planning and decision-making. <https://coast.noaa.gov/digitalcoast/training/community-resilience-part-i-assessing-vulnerabilities-using-the-roadmap-for-adapting-to.html>
- NOAA's *Adapting to Climate Change: A Planning Guide for State Coastal Managers* is a guide to assist coastal managers develop and implement adaptation plans to reduce the risks associated with climate change impacts. <https://coast.noaa.gov/czm/media/adaptationguide.pdf>
- *Understanding Your Risks: Identifying Hazards and Estimating Losses* provides step-by-step guidance on how to conduct a risk assessment. <https://www.fema.gov/media-library/assets/documents/4241>

### Precipitation Data

- Cornell's *Extreme Precipitation Analysis in New England* is an interactive web tool for extreme precipitation analysis and includes estimates of extreme rainfall for various durations and recurrence intervals. <http://precip.eas.cornell.edu/>
- NOAA NWS Hydrometeorological Design Studies Center *Precipitation Frequency Data Server* (PFDS) is an interactive web tool delivering NOAA Atlas 14 precipitation frequency estimates and associated information. <http://hdsc.nws.noaa.gov/hdsc/pfds/>
- Department of Homeland Security Regional Resiliency Assessment Program, *Casco Bay Region Resiliency Assessment*. <http://www.northeastern.edu/kostas/wp-content/uploads/2017/03/Maine-RRAP-RA-FINAL-no-links.5-13.pdf>
- Department of Homeland Security Regional Resiliency Assessment Program - *Casco Bay Region Assessment* summary report, downscaled climate models, radar-based rainfall data, and Intensity, Duration, and Frequency (IDF) curves for precipitation. <http://www.northeastern.edu/kostas/rrap/>

### Data Collection Tools

- Wetlands Watch *Sea Level Rise* mobile application is a crowdsourcing platform for gathering real-time, georeferenced data on local flooding and impacts. <http://wetlandswatch.org/sea-level-rise-phone-app/>
- U.S. Army Corps of Engineers' *Mobile Information Collection Application* (MICA) is user-friendly, cost-effective web-based and mobile application for digital collection and

transfer of flood data. <http://www.erdc.usace.army.mil/Media/Fact-Sheets/Fact-Sheet-Article-View/Article/476670/mobile-computing-mica-and-blue-roof/>

## **Recommendations**

- Integrate information about current and potential future flood risk and hazards into your community's existing planning, policies, and activities to protect people, homes, and infrastructure, now and into the future.
- Partner with local universities and colleges to identify and operationalize opportunities for faculty and student research to help answer questions your community has and inform local decision-making.

## **II. Critical Infrastructure and Facilities**

### **Resources**

#### Assessing Vulnerability

- NOAA's *Coastal Flood Exposure Mapper* is an online visualization tool for assessing coastal hazard risks and vulnerabilities, including vulnerability of critical infrastructure. <https://coast.noaa.gov/digitalcoast/tools/flood-exposure.html>

#### Engineering and Design

- *StreamStats Version 4* is a GIS-based web application developed by the U.S. Geological Survey for calculating drainage basin characteristics and streamflow statistics for user-selected sites on rivers and streams in Maine. It provides an assortment of analytical tools for water-resources planning and management and engineering and design purposes for rivers, streams, and watersheds. <http://water.usgs.gov/osw/streamstats/>
- *New England Interstate Water Pollution Control Commission* (NEIWPCC) is an interstate agency that coordinates regional activities to meet the water-related needs of New England states by providing leadership in water management and protection, helping to establish design standards for wastewater treatment facilities, and participating in training and certification of treatment plant operators. <http://www.neiwpcc.org/>

#### Funding

- The Maine Department of Environmental Protection oversees the Revolving Loan Funds program, which offers low-interest loans to improve municipal and quasi-municipal wastewater treatment infrastructure. Communities that make investments to have high-quality, safe, and sustainable wastewater facilities will see the return from businesses that want to locate or expand to their towns and cities. These projects will improve resiliency and can save taxpayers money by reducing future repairs and upgrades while maintaining service functionality. <http://www.maine.gov/dep/water/grants/srfparag.html>
- U.S. EPA's Water Infrastructure and Resiliency Finance Center provides resources on financing disaster recovery and mitigation for water and wastewater utilities. <https://www.epa.gov/waterfinancecenter/financing-disaster-recovery-and-resilience-mitigation-water-and-wastewater>

#### Adaptation and Mitigation

- U.S. EPA developed *Flood Resilience: A Basic Guide for Water and Wastewater Utilities* to assist small and medium-sized water and wastewater utilities with protecting critical

assets from flood hazards. [https://www.epa.gov/sites/production/files/2015-08/documents/flood\\_resilience\\_guide.pdf](https://www.epa.gov/sites/production/files/2015-08/documents/flood_resilience_guide.pdf)

- U.S. EPA's offers guidance on assessing risk, emergency response, recovery, and training for drinking water and wastewater resilience. <https://www.epa.gov/waterresilience>

## Recommendations

- Incorporate existing and potential future coastal hazards into design standards, capital improvements planning, and regulations for critical infrastructure.
  - The Berwick Water Department and U.S. EPA engineers conducted a pilot project to evaluate the flooding risk and resilience of drinking and wastewater infrastructure in the town and determine actions to improve the utility's resilience to flooding. <https://toolkit.climate.gov/case-studies/small-water-utility-builds-flood-resilience>
- Conduct a detailed vulnerability assessment of potential flood impacts to your critical infrastructure and facilities.
  - The Saco Bay Sea Level Adaptation Working Group (SLAWG) undertook an assessment of the potential impacts of sea level rise and storm surge scenarios on public and private roads within the Saco Bay region. The summary report, *Road Infrastructure Assessment Report*, outlines the methodology and findings. <http://www.smrpc.org/images/SLAWG/FINAL%20SLAWG%20DOC%203.pdf>
- Develop an inventory of prioritized infrastructure and facilities vulnerable to existing flood hazards and future sea level rise to inform upgrade, repair, and replacement projects.
- Adapt and adopt existing federal floodplain management and development policies for guiding public and/or private development in your community. Examples of such federal policies include:
  - Executive Order (EO) 11988 requires federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. Under the order, federal agencies funding and/or permitting critical facilities are required to avoid the 0.2% (500-year) floodplain or protect facilities to the 0.2% chance flood level. <https://www.fema.gov/executive-order-11988-floodplain-management>
  - EO 13690 amended EO11988 and established a Federal Flood Risk Management Standard (FFRMS) requiring federal actions to use one of the following approaches for establishing flood elevation and hazard area they use in siting, design, and construction: best-available, actionable climate science; two feet above the 100-year (1% annual chance) flood elevation for standard projects and three feet above for critical buildings like hospitals and evacuation centers; or build to the 500-year (0.2% annual chance) flood elevation. <https://www.fema.gov/federal-flood-risk-management-standard-ffrms>

## III. Community Planning

### Resources

Land Use Planning and Development NOAA's Smart Growth for Coastal and Waterfront Communities is a guide developed by NOAA, U.S. EPA, the International City/County Management Association, and Rhode Island Sea Grant that builds on smart growth principles to

create coastal and waterfront-specific strategies for development. It is aimed at planners, local government officials, developers, residents, and other stakeholders.

<http://coastalsmartgrowth.noaa.gov/>

- U.S. EPA offers resources and guidance on smart growth approaches that can help communities prepare for and recover from natural disasters. <https://www.epa.gov/smartgrowth>

#### Disaster Preparedness, Response, and Recovery

- *Natural Disaster Debris Management Site Planning: Considerations for York County Coastal Communities* is a report drafted by the Southern Maine Planning and Development Commission, in partnership with the York County Emergency Management Agency, that provides an overview on identifying potential debris management sites and understanding the logistics that surround choosing these sites. Specific suggestions and observations are also included in the report as well as a more extensive list of helpful materials. <http://www.smrpc.org/images/SLAWG/Report%20on%20Debris%20Site%20Identification%20May%202016.pdf>
- FEMA Integrated Public Alert and Warning System (IPAWS) allows community officials to provide the public with emergency information. <https://www.fema.gov/integrated-public-alert-warning-system>
- Maine Emergency Management Agency provides guidance materials and planning resources for emergency preparedness for schools and students. <http://www.maine.gov/mema/prepare/schools/index.shtml>

#### Adaptation and Mitigation

- Maine Sea Grant's *Property Owner's Guide to Managing Flooding, Erosion & Other Coastal Hazards* was created to help coastal property owners and municipal officials identify features and different types of hazards on the Maine coast, and evaluate responses and actions. <http://www.seagrants.umaine.edu/coastal-hazards-guide>
- U.S. EPA's *Smart Growth Fixes for Climate Adaptation and Resilience* is a guide designed to assist local government officials, staff, and boards find strategies to prepare for climate change impacts through land use and building policies. The guide includes case studies and adaptation strategies organized by hazard and categorized by ease of implementation. <https://www.epa.gov/smartgrowth/smart-growth-fixes-climate-adaptation-and-resilience>
- National Weather Service *StormReady Program* helps communities respond to hazardous weather by providing emergency managers with clear-cut guidelines on how to improve their hazardous weather operations. <http://www.stormready.noaa.gov/>

#### Funding

- Maine Coastal Program oversees grant programs for coastal community planning, coastal access, and working waterfronts. <http://www.maine.gov/dacf/mcp/grants/index.html>
- FEMA administers Hazard Mitigation Assistance (HMA) grant programs to assist states, federally recognized tribes, and local communities with eligible mitigation planning and projects that reduce disaster losses. The Pre-Disaster Mitigation (PDM) program provides funds for hazard mitigation planning and projects on an annual basis and Flood



Mitigation Assistance (FMA) program provides funds for planning and projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program. <https://www.fema.gov/hazard-mitigation-assistance>

- U.S. Army Corps of Engineers' Maine Silver Jackets team, an interagency group of federal and state partners, provides annual funding for flood risk reduction projects. <https://silverjackets.nfrmp.us/State-Teams/Maine>

## Recommendations

- Develop a resilience plan and/or integrate resiliency into existing community plans and policies.
- Establish a municipal fund to support local resiliency efforts.
  - Communities in the San Francisco Bay area have implemented a \$12 annual tax
- Integrate hazard mitigation into your community's comprehensive plan.
- Consider offering incentives to encourage private property owners to voluntarily implement flood risk reduction practices.
  - The town of Hull, MA offers a \$500 credit toward development permitting cost if property owners elect to incorporate at least two feet of freeboard into their construction. <http://www.mass.gov/eopss/docs/mema/resources/mitigation/freeboard-incentive-program-hull.pdf>
- Establish a low-interest loan program to provide financing to private property owners to retrofit homes and businesses to be more resilient to impacts from flooding and extreme storms.
  - Connecticut developed its "Shore Up Connecticut" program to provide financial assistance for flood-resilience retrofits for property owners that were not eligible for federal disaster aid after Sandy. Both home and business owners are eligible for loans under the program and can borrow up to \$300,000 to pay for flood resilience improvements. <http://shoreupct.org/>
- Post signs or markers indicating historical flood depths and/or potential future sea levels in publicly visible areas around your community to increase awareness of local flood risk and encourage action to mitigate that risk. FEMA's High-Water Mark Initiative is a community-based program that offers guidance, resources, and standardized signage for communicating local flood risk. <https://www.fema.gov/high-water-mark-initiative>
- [Encourage or require property buyers to review flooding and sea level rise risks to property with municipal staff and sign a form acknowledging the risk.](#)
- [Adopt](#) zoning and/or floodplain ordinances that apply to flood hazard areas that extend beyond, horizontally and/or vertically, those identified as the 100-year floodplain depicted on your community's Flood Insurance Rate Map (FIRM) to account for existing and potential future flood hazard areas.
  - [The City of Northampton, Massachusetts changed its regulatory floodplain boundaries from FEMA's 100-year floodplain to the 500-year floodplain as a surrogate for climate change. <http://www.northamptonma.gov/1415/Hazard-Mitigation>](#)
  - [The Georgetown Climate Center developed a model zoning ordinance, which was tested in communities in Connecticut and Maryland, that extends the boundaries of the areas subject to floodplain regulations to protect development that will](#)

[become increasingly vulnerable to flood hazards as sea levels rise.](http://www.georgetownclimate.org/reports/zoning-for-sea-level-rise.html)  
<http://www.georgetownclimate.org/reports/zoning-for-sea-level-rise.html>

- C \_ Collaborate with property owners located in areas vulnerable to flood hazards to form a district in which property owners opt in to participate, wherein the district would use capital raised by issuing bonds to make resiliency improvements, which is paid back through a property tax assessment.

## IV. Social and Economic Vulnerability

### Resources

- *Integrating Historic Property and Cultural Resource Consideration into Hazard Mitigation Planning* is a guidance document developed by FEMA that provides a step-by-step method for developing and implementing a pre-disaster planning strategy for historic properties and cultural resources. [fema.gov/environmental-planning-and-historic-preservation-program/](https://www.fema.gov/environmental-planning-and-historic-preservation-program/)
- NOAA's *Quick Report Tool for Socioeconomic Data* provides easy access to downloadable economic and demographic data for coastal areas. <https://coast.noaa.gov/digitalcoast/tools/qrt.html>
- *Surging Seas* is a web-based sea level rise analysis mapping tool developed by Climate Central that allows users to see areas potentially affected by sea level rise and storm surge, down to the neighborhood scale, and with risk timelines. It also provides population statistics, summaries of homes and land affected by sea level rise and storm surge, fact sheets, data downloads, and action plans. <http://sealevel.climatecentral.org/>
- The U.S. Census Bureau provides interactive web-based tools for examining and visualizing federal social and economic data from the Census and American Community Survey. <https://www.census.gov/data.html>
- In many Maine communities and counties, emergency management is supported by volunteer teams that have received special training to support first responders and perform important response functions. Most of these teams receive basic training as Community Emergency Response Teams (CERT), and then may specialize in a particular type of response such as amateur radio or animal and pet care. [http://www.maine.gov/mema/prepare/community/prep\\_community\\_cert.shtml](http://www.maine.gov/mema/prepare/community/prep_community_cert.shtml)

### Recommendations

- Identify local organizations and groups that can help build support and engagement within the community for understanding flood vulnerability and increasing resilience.
- Encourage and provide assistance to local businesses to register as approved vendors for federal post-disaster procurement processes. [https://www.sba.gov/sites/default/files/disaster\\_contracting.pdf](https://www.sba.gov/sites/default/files/disaster_contracting.pdf)
- Encourage your Chamber of Commerce and local businesses to assess their vulnerability to coastal flood hazards and assess how well prepared they are for flooding events.



- Mississippi-Alabama Sea Grant developed the *Tourism Resilience Index: A Business Self-Assessment: Understanding How Prepared Your Business is for a Disaster.*  
[http://masgc.org/assets/uploads/publications/1142/tourism\\_resilience\\_index.pdf](http://masgc.org/assets/uploads/publications/1142/tourism_resilience_index.pdf)

## V. Natural Resources

### Resources

- The Maine Coastal Program *Stream Habitat Viewer* is an online map viewer that displays stream habitats for species important to Maine's economy, ecology, and way of life and provides information about dams and road crossings that can act as barriers to fish passage and stream health. <http://www.maine.gov/dacf/mcp/environment/streamviewer/>
- Maine Natural Areas Program developed GIS data related to tidal marshes, marsh migration, and undeveloped coastal areas with the potential to support future tidal marsh under a one-foot sea level rise scenario.  
[http://www.maine.gov/dacf/mnap/assistance/coastal\\_resiliency.html](http://www.maine.gov/dacf/mnap/assistance/coastal_resiliency.html)
- [The Nature Conservancy's Coastal Resilience](http://maps.coastalresilience.org/maine/) platform is a web mapping tool that allows users to examine nature's role in reducing coastal risks and opportunities for habitat conservation in Maine. <http://maps.coastalresilience.org/maine/>
- [NOAA's Green Infrastructure Mapping Guide](http://coast.noaa.gov/digitalcoast/training/gi-mapping.html) shows spatial analysts how to incorporate nature-based solutions, or green in infrastructure, into their GIS work. <http://coast.noaa.gov/digitalcoast/training/gi-mapping.html>
- NOAA's *How to Consider Climate Change in Coastal Conservation* is an online resource that walks the user through the step-by-step approach identified in the *Guide for Considering Climate Change in Coastal Conservation* that can be used to create a new conservation plan or update an existing one that incorporates climate change information. The approach draws from existing strategic conservation planning frameworks but focuses on climate considerations and key resources specifically relevant to the coastal environment. <http://coast.noaa.gov/digitalcoast/training/coastal-conservation.html>

### Recommendations

- Adopt land use regulations that require expanded setbacks to protect buffer areas around natural resource areas.
- Adopt land use regulations and/or zoning ordinances to protect, accommodate, and facilitate future marsh migration.
- Identify and prioritize conservation areas that offer multiple benefits such as flood protection, wildlife habitat, recreation, and CRS credit.
- Utilize buy-out options of properties repeatedly damaged by coastal hazards and preserve those areas as open space.
- Develop easement language for coastal properties that accounts for sea level rise and subsequent changes to property boundaries.
- Identify opportunities to restore, conserve, or enhance natural protective features.

Municipal officials in Provincetown, MA undertook a managed retreat of a beachfront parking lot that was at risk from erosion. The town demolished the existing parking lot and constructed a new lot 125ft inland, allowing for restored shoreline in the original footprint of the lot. [http://www.nytimes.com/2016/07/07/us/at-a-cape-cod-landmark-a-strategic-retreat-from-the-ocean.html?\\_r=0](http://www.nytimes.com/2016/07/07/us/at-a-cape-cod-landmark-a-strategic-retreat-from-the-ocean.html?_r=0)

## Appendix E

### Definitions Addendum

**Adaption** looks at how to reduce the negative effects of climate change and how to take advantage of any opportunities that arise.

**Climate resilience** is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate.

**Climate resilience improvement** involves assessing how climate change will create new, or alter current, climate-related risks, and taking steps to better cope with these risks.

**Highest annual tide (HAT)** published yearly by Maine Geological Survey (Megis), is the elevation of the highest predicted astronomical tide expected to occur at a specific tide station over the year

**King tides** are the highest predicted astronomical tides. Used in this document they are the highest predicted astronomical tide each month.

**Mitigation** is aimed at tackling the causes and minimizing the possible impacts of climate change,

**Sea level rise (SLR)** is a rise in the standing water level in comparison to the established high tide level for that date. The **causes** of global **sea level rise** can be roughly split into three categories: (1) thermal expansion of sea water as it warms up, (2) melting of land ice and (3) changes in the amount of water stored on land.

**Socio/Economic vulnerability** is an additional community stressor toward achieving climate resilience.

**Storm surge** is the abnormal rise in seawater level during a storm, measured as the height of the water above the normal predicted astronomical tide. The surge is caused primarily by a storm's winds pushing water onshore.